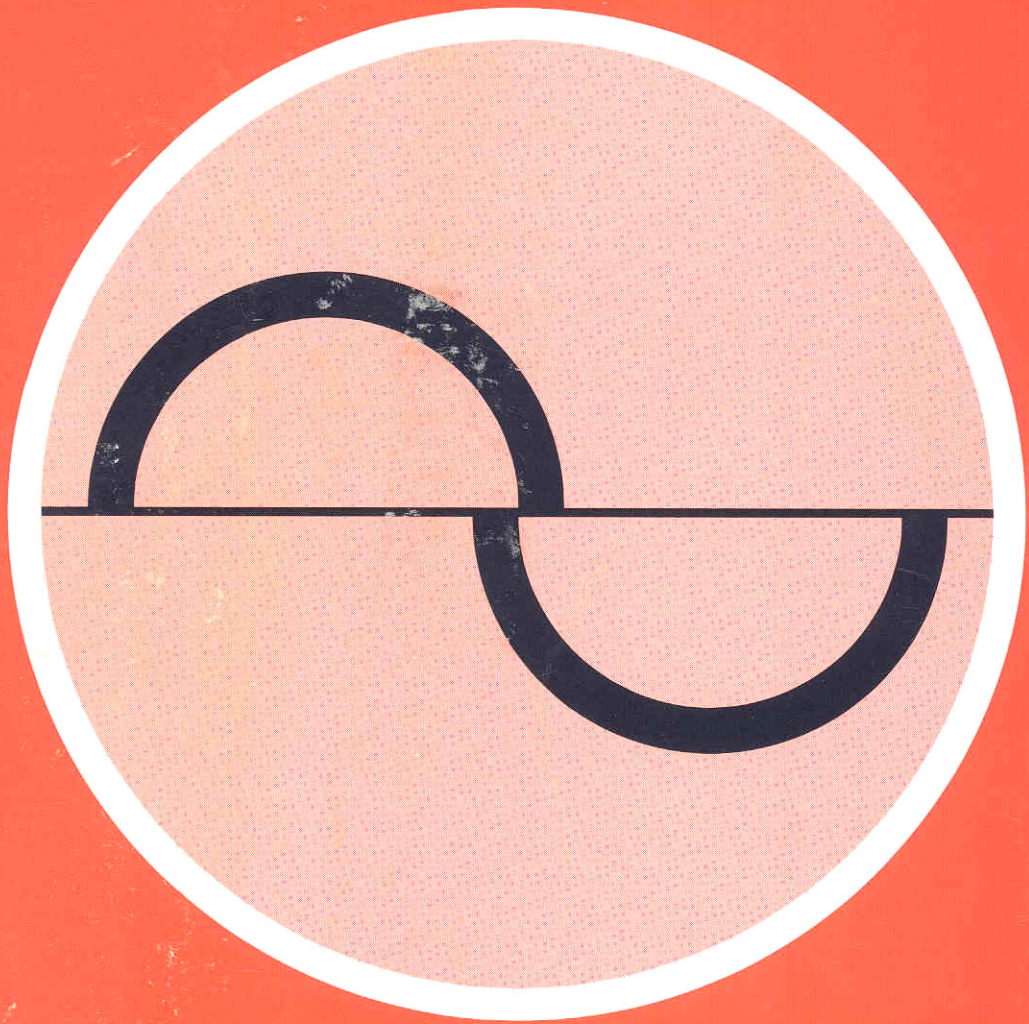


Goldmann

Applanation Tonometer

Models 900.4.1, 900.4.2, 900.4.4, 870 and 1080

HAAG-STREIT AG Ophthalmological Instruments 3097 Liebefeld-Berne/Switzerland

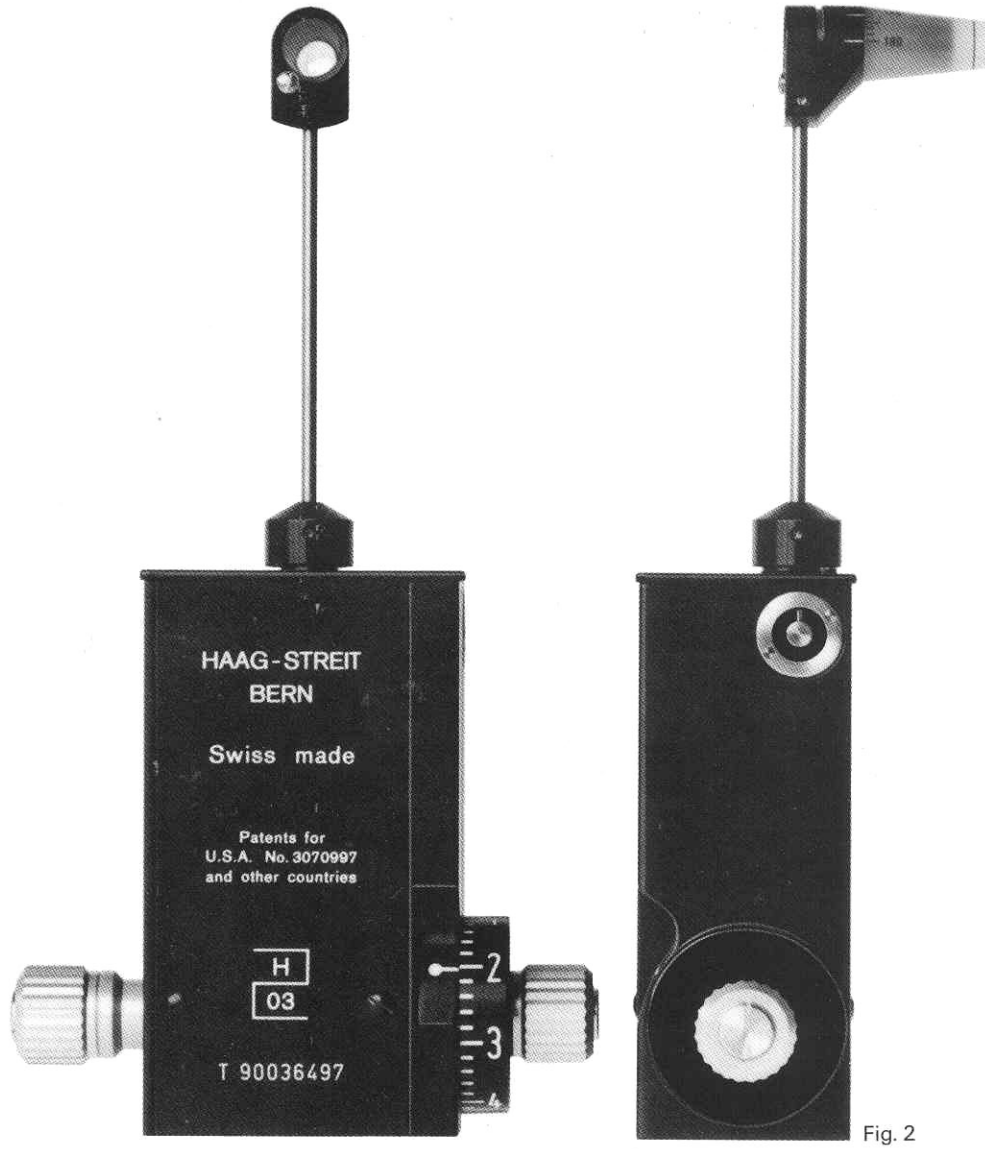


Fig. 2

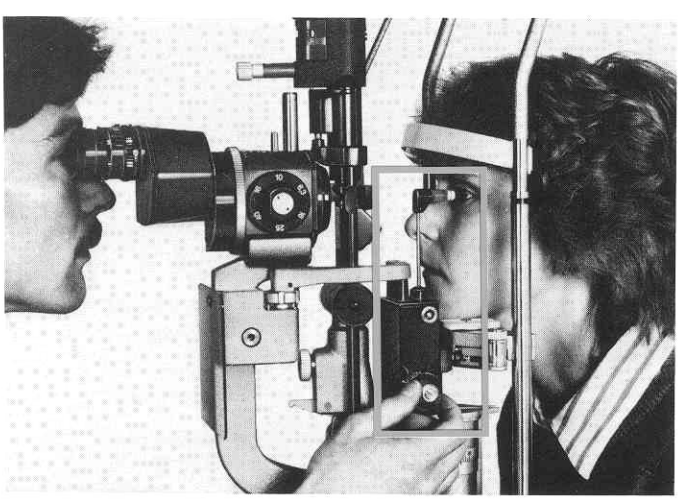


Fig. 1

The Applanation Tonometer is based on the following principle:

Measurement of the force necessary to flatten a corneal surface of constant size.

The exact measurement of the small flattened surface is made with the microscope of the slit lamp with a magnification of 10 times. This tonometer then combines the following advantages:

1. Tonometric measurement is carried out at the slit lamp with the patient seated. It becomes a routine examination together with the ordinary biomicroscopic examination.
2. Great accuracy is achieved. The average error does not exceed $\pm$ 0.5 mm Hg.
3. Direct reading of the intraocular pressure in mm Hg is effected.
4. Scleral-rigidity is not to be taken into account as the small volumetric displacement of 0.56 mm^3 increases the intraocular tension by about 2.5% only.
5. As only a very small increase in the tension is caused by the applanation tonometer, no massage effect is produced by repeated measurements, hence such measurements do not show a decrease in intraocular tension.
6. There are no difficulties of standardisation or calibration.

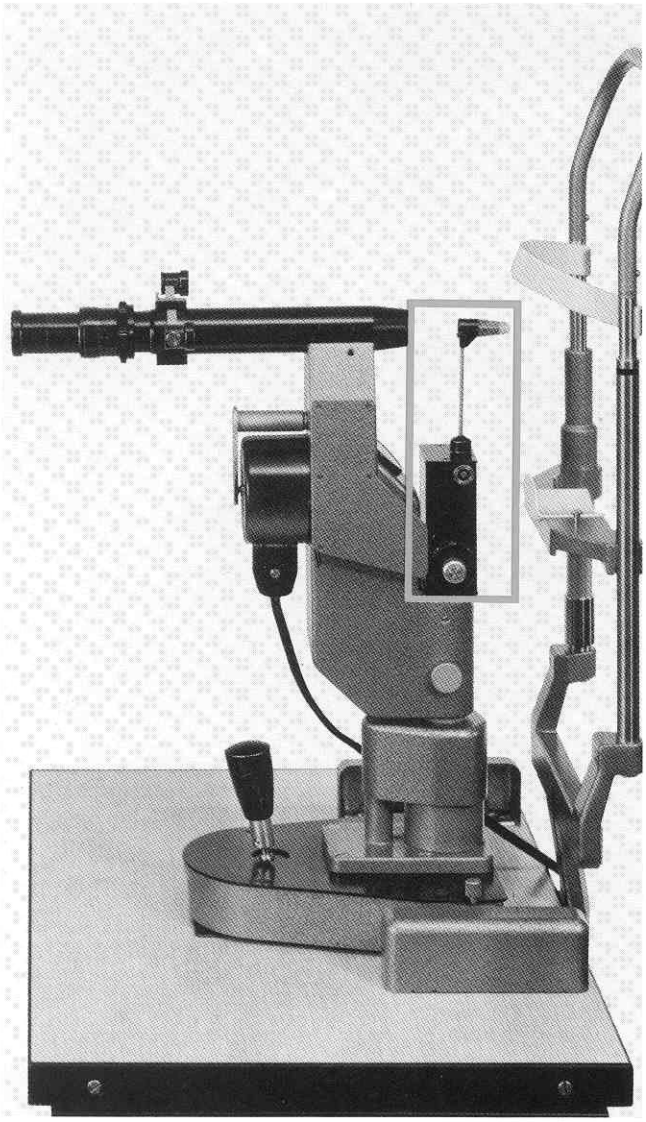


Fig. 5

Model 1080

The tonometer 1080 (fig. 5) is based on the design of the Goldmann applanation tonometer and is ideal for

mass screening
diagnosis of glaucoma
checking of tensions of glaucoma patients
diurnal pressure curves.

Optimal conditions ensure quick and reliable results. The flattened cornea is observed with the right eye through a monocular microscope. The illumination of the applanated area is bright, uniform and free of reflection being illuminated at an angle of 45° from below. A fixation point 20 cm from the patient's eye facilitates tonometry so that on most occasions the eye lids do not have to be spread. The fixation point is just above the microscope axis, therefore, the patient looks up 4–5°. The tonometer prism is observed through a loupe of low magnification during measurements to ensure that it does not touch the lids or eye lashes. To enable the measurement to be made through the microscope and observation through the loupe simultaneously, the loupe can be laterally adjusted to suit individual interpupillary distances.

The pressure on the tonometer is mirrored into the eye-piece which is visible only by lateral movement of the head to the right, but not during examination.

The eye-piece has to be set according to the refraction or accommodation of the examiner similarly as with the 900 slit lamp. It is in correct adjustment when the tonometer scale is sharply in focus.

The tonometer 1080 is adjusted laterally and vertically with the single joystick control on the cross-slide. It can be rotated around its axis by 30° to both sides so that patients with paralytic strabismus can be measured as well. The accessory box contains a sterilizing bowl, a bottle of disinfectant for the prisms, a bottle for anaesthetic placed on a small warming plate, fluorescein paper strips, a checking weight and measuring prisms.

The tonometer 1080 is a complement to the slit lamp applanation tonometer. While the latter fits harmoniously into the routine of the slit lamp examination, the advantage of the tonometer 1080 is, however, in examining a large number of glaucoma patients or glaucoma suspects where the optimal conditions for reliable applanation tonometry permits the ophthalmologist to entrust a medical technician with the tonometry, after the necessary teaching and practice.

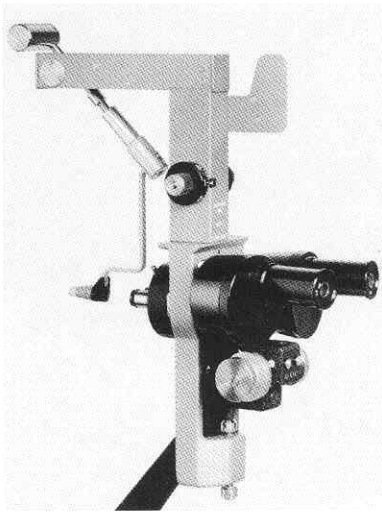


Fig. 6

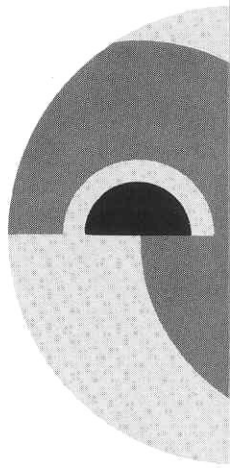


Fig. 7. Prism touches t
without pressure

Model 870

The applanation tonometer is mounted above the binocular microscope of the slit lamp and is fixed on a square support (fig. 6). The arm, which serves to measure the pressure comes from the upper part of the apparatus and is interposed in front of the microscope in the optical light wedge.

When the arm is returned to its position of rest, it does not interfere with the ordinary examination with the slit lamp. A simple rotation of the arm prepares the tonometer for use. Before measuring the pressure, the cornea must be superficially anaesthetised, a strip of fluorescein paper placed into the lower fornix and the blue filter interposed before the light source.

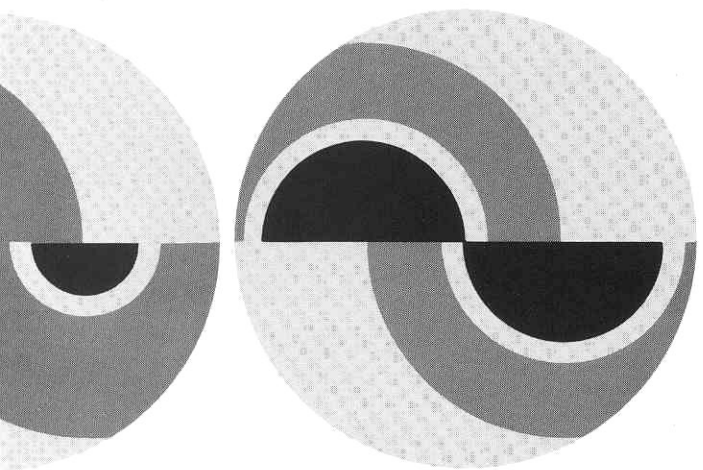
Description

The cornea is flattened with a prism made of plastic. The anterior surface is flat, its diameter being 7.0 mm. The borders are rounded in order to avoid injuring the cornea.

The prism is brought into contact with the cornea by advancing the slit lamp (fig. 7). Then, by turning the measuring drum which regulates the force applied to the pressure arm, the tension on the eye is increased until a surface of known and constant size of 3.06 mm dia. = 7.354 mm² is flattened (fig. 8).

The following table shows the relation between the position of the measuring drum, the force and pressure required for flattening an area of the above size.

Position of the measuring drum	Force	Pressure
1	1 Pond (1 Gram)	10 mm Hg
1	9.81 mN	1.33 kPa



cornea

Fig. 8. The diameter of the flattened surface is 3.06 mm

The intraocular pressure in mm Hg is found by multiplying the drum reading by ten.

Before measuring the pressure, the cornea must be superficially anaesthetised, a strip of fluorescein paper placed into the lower fornix and the blue filter inserted in the path of light. Where the prism touches the cornea, the fluid is pushed to the periphery of the contact zone and so forms a distinct yellow-green ring.

The inner border of the ring represents the line of demarcation between the cornea flattened by applanation and the cornea not flattened.

The major advantage of applanation tonometry is the small bulbus deformation which amounts to only 0.56 mm³. The values found by this method of tonometry are only slightly influenced by scleral-rigidity and radius of corneal curvature.

The table (fig. 9) presents a comparison between the P_O values which are obtained with a Schiötz tonometer and an applanation tonometer for different radii of corneal curvature and for different coefficients of scleral rigidity. This table clearly demonstrates the considerable differences possible in using the Schiötz tonometer when the rigidity of the globe and the radius of the cornea are not taken into consideration.

On the other side it also shows the minimal difference between the pressure measured P_t and the actual intraocular pressure P_O with the applanation tonometer. This difference is so small, that in practice the value read on the drum can be considered the value of the actual intraocular pressure.

	Schiötz Tonometer			Applanation Tonometer		
	weight 7.5 g reading 5 P_t = 42.6 mm Hg			reading on the measuring drum P_t = 26.5 mm Hg		
Corneal radius	Rigidity 0.0050	0.0215	0.0350	Rigidity 0.0050	0.0215	0.0350
4.5	29.1	8.3	3.0	26.2	25.2	24.5
7.8	37.9	**25.8***	18.8	26.3	**25.8**	25.3
15.5	40.8	35.2	31.2	26.3	26.1	25.9

Fig. 9 * according to calibration table 1955/57 (Dr. J. Friedenwald)

When corneal astigmatism is present, the zone flattened by applanation is no longer a round surface but an elliptical one. Nevertheless, even in these cases it is possible to precisely measure the intraocular pressure.

A check of the tonometer can be made with the aid of a control weight. It is recommended that the applanation tonometer, especially the model T 900, be supplied complete with the accessory box which is fixed to the table and which contains, the heater for the anaesthetic, the clip to accomodate the fluorescein paper strips, the special dispensing bottle for the disinfectant, the dispenser for cotton wool and the waste box.

The principle of applanation tonometry is simple. The careful construction of the apparatus is a guarantee of its continued correct performance. It is easily checked. Nevertheless, in order to obtain exact results, the method of use indicated must be strictly followed.

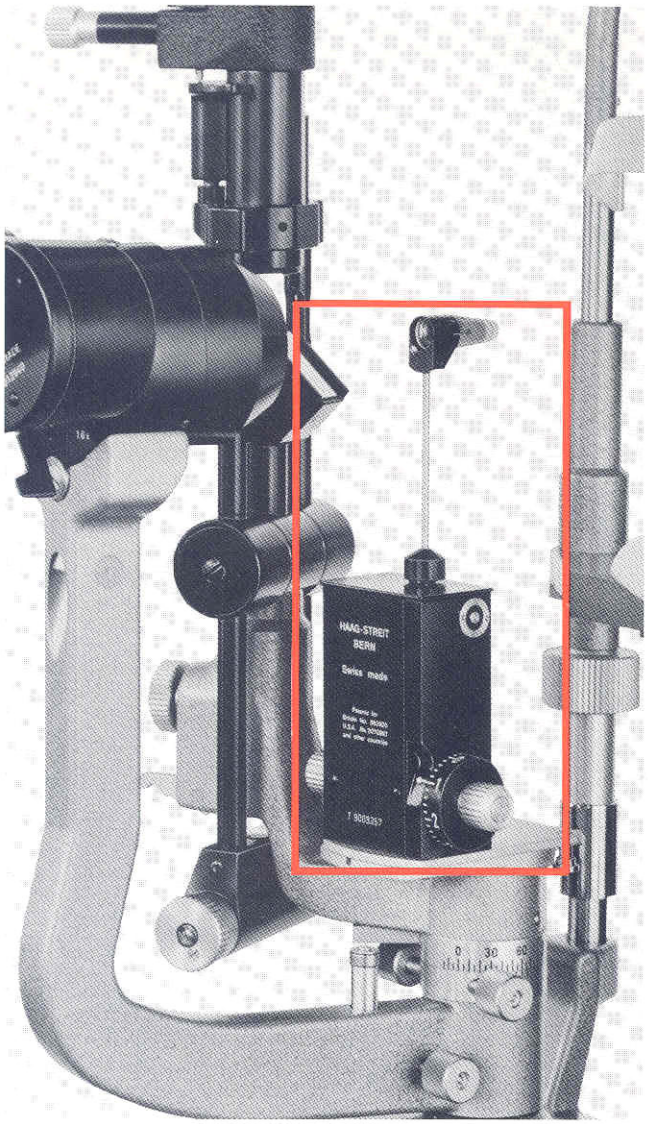


Fig. 3. Tonometer 900.4.1

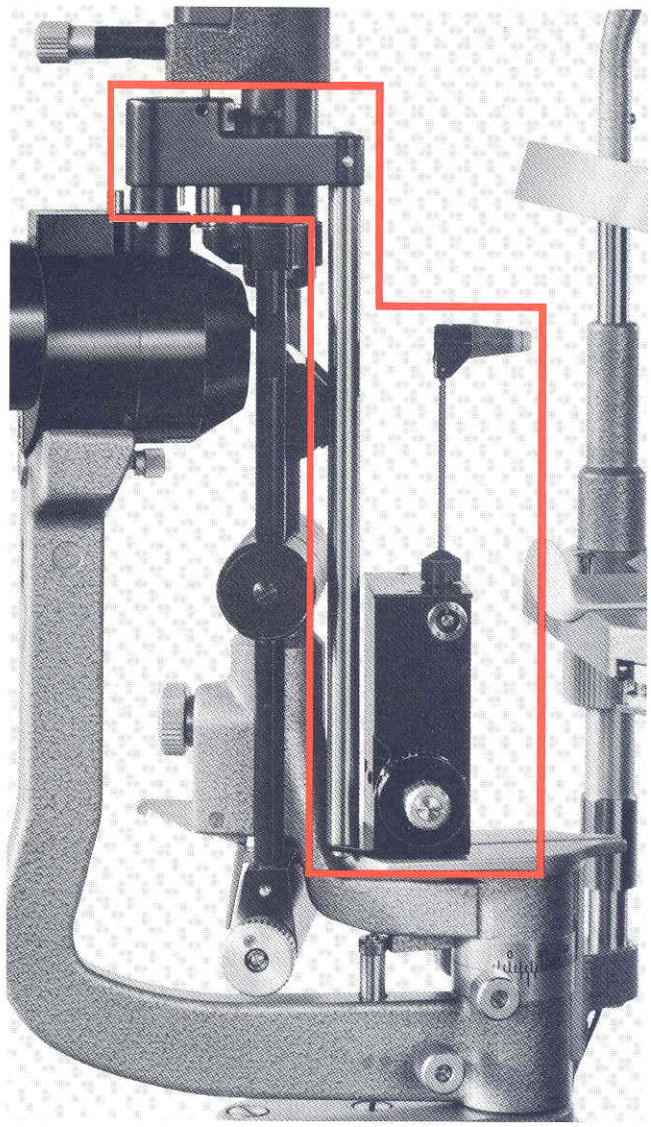
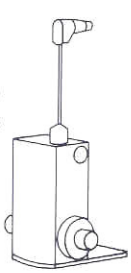


Fig. 4. Tonometer 900.4.2

Model 900.4.1 (T 900)

for Haag-Streit Slit Lamps 900® BM, CN and BQ

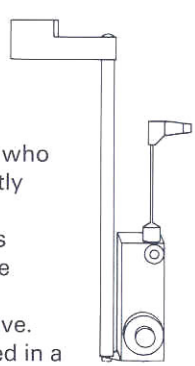


To use, the 900.4.1 is simply lifted out of the accessory box and placed on the guide plate in one of two possible positions (fig. 3). These positions are related to the microscope, for observation can be made either through the right or the left eye-piece. The doubling prism, which is held in a ring at the extremity of the pressure arm, is automatically in the path of the microscope and the illumination. In order to obtain an image as clear and as free of reflexes as possible, the angle between the illumination and the microscope should be about 60° and the slit diaphragm should be opened completely.

A similar tonometer, 900.4.3 (Z 900) is available for the Zeiss Slit Lamp.

Model 900.4.2 (R 900)

for Slit Lamps 900® BM and CN



The 900.4.2 is being produced for those who wish the tonometer to remain permanently on the slit lamp. It is mounted on a pivot on the microscope and for examination is swung forward in front of the microscope (fig. 4). A notch position ensures exact centring of the prism with the left objective. When not in use the instrument is secured in a notch position to the right of the microscope. Observation of the flattened area of the cornea is made through the left eye-piece only.

The illumination device is moved from the left until it just touches the tonometer support and in this position the area of contact is illuminated through the prism and is free of reflection. Also there is more space to hold open the patient's eye. The pivot support for the 900.4.2 tonometer also serves to hold the photographic attachment, the depth measuring devices and other attachments. When any of these are used the tonometer must first be lifted off its pivot.

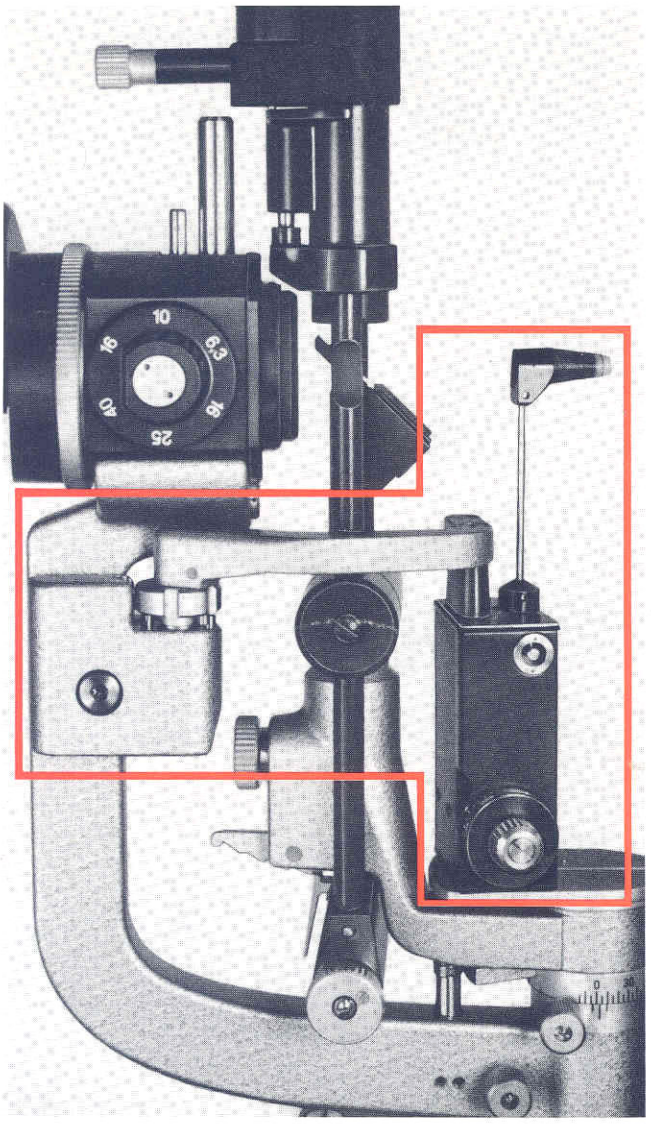
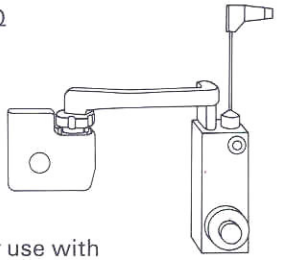


Fig. 10. Tonometer 900.4.4

Model 900.4.4

for Haag-Streit Slit Lamp 900® BQ



The 900.4.4 has been adapted for use with the stereo-microscope 900.7. It has two rest positions and one measuring position and remains permanently on the slit lamp.

For perfect tonometric examination of the left and right eye of the patient the tonometer is swung in front of the microscope and the illumination unit moved from the left to touch the bracket of the tonometer. There is no 60° angle between illumination and microscope.

Observation of the flattened area of the cornea is made monocularly through the right eyepiece only.

The 900.4.4 is fixed on the microscope arm. The pivot support on the microscope remains free for holding other attachments such as the depth measuring devices, the visometer etc.

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